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USA Continuation Patent Application of:

Keiji Hanawa
Serial No: 09/238,228
Filed: January 27, 1999

VEHICLE SURROUNDINGS
MONITORING APPARATUS

Examiner: Mahmood Barry Choobin
Group art unit: 2621

CERTIFICATE OF MAILING ON LAST PAGE

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

S I R :

PRELIMINARY AMENDMENT

Please amend this application simultaneously with the filing of this Continuation Application as follows:

IN THE SPECIFICATION

Please replace the paragraph beginning at page 10, line 11, with the following rewritten paragraph:

Further, based on the arrangement direction of the distance data of the overall groups, i.e., the gradient with respect to the Z-axis, the groups are classified into faced wall groups or side wall groups. For the faced wall groups, parameters such as a mean distance, X coordinates of the left and right ends and the like are calculated from the distance data of the group. Further, for the side wall groups, parameters such as the arrangement

direction (gradient with respect to the Z-axis), the positions of the forward and backward ends in terms of Z-X coordinates and the like are calculated. Thus, the side surface of a solid object and the structure such as a guardrail are detected as the side wall arranged along the road.

Please replace the paragraph beginning at page 11, line 8, with the following rewritten paragraph:

The programs shown in Figs 3 through 5 are ones for classifying the faced wall group and the side wall group by processing the distance data obtained from the distance image.
First, at a step S101, the distance image is divided into lattice-like strips having a given interval (for example 8 to 20 picture elements) and at S102 data of a solid object are extracted for every strip and the data of the first strip are read to calculate the distance to the object.

Please replace the paragraph beginning at page 15, line 11, with the following rewritten paragraph:

That is, at S121 the data of the first group are read and at S122 the arrangement direction of the data of the respective strips is calculated. Further, at S123 these strips are labeled as faced wall or "side wall", respectively. Specifically, first two points on the X-Z plane are picked up from the data of the first group. One point (X1, Z1) is a middle point of a strip K1 at the left end of the first group and the other point (Xp, Zp) is a middle point of a strip far away from the left end strip K1 by an

interval of N strips in the right hand direction. Then, a line connecting these two points is drawn on the X-Z plane and a gradient A1 of the line is calculated. When the gradient A1 is compared with a prescribed value, for example 45 degrees, if the gradient A1 is larger than the value, the strip K1 is labeled as "side wall" and if the gradient A1 is smaller than the value, the strip K1 is labeled as faced wall.

Please replace the paragraph beginning at page 15, line 26, with the following rewritten paragraph:

The interval N between strips is preferably N = 2 to 4. The reason is that N = 1, namely, an adjacent strip may produce fluctuations in the arrangement direction of the data due to the dispersion of detected distance and as a result it becomes difficult to make discrimination between "side wall" and faced wall. Therefore, it is suitable to use not an adjacent strip, but a strip a little distant. Hereinafter, the labeling of "side wall" or faced wall is performed successively from the left end strip up to the strip apart by N strips on the left side of the right end strip.

Please replace the paragraph beginning at page 16, line 8, with the following rewritten paragraph:

When the labeling is accomplished for each strip of the group, the program goes from S123 to S124 where the label of the left end strip is read and at the next step S125, the label of the right adjacent strip is read. Then, it is investigated whether or

not the label of the left end strip is different from that of the right adjacent strip. As a result, if the label of the left end strip is the same as that of the right adjacent strip, the program skips to S128 and if different, the program steps to S127 where the strip labeled "side wall" and the strip labeled faced wall are divided into different groups respectively. The division of the group is performed at the position apart by N/2 strip on the right side of the position where the label changes from "side wall" to faced wall and vise versa.

Please replace the paragraph beginning at page 17, line 8, with the following rewritten paragraph:

The following steps S132 to S137 are of processes in which further classifications of "side wall" or faced wall are carried out to raise the accuracy of the classification performed at S127. After the data of the first group are read at S132, at S133 approximate straight lines are obtained from the positions (Xi, Zi) within the group according to the Hough transformation or the linear square method to calculate a gradient overall the group.

Please replace the paragraph beginning at page 17, line 16, with the following rewritten paragraph:

Then, the program goes to S134 where the group is reorganized such that the group having a gradient inclined toward X-axis is classified into the faced wall group and the group having a gradient inclined toward Z-axis is classified into the "side wall" group. Further, at S135, miscellaneous parameters of the

group are calculated. With respect to the group classified faced wall, these parameters include an average distance which is calculated from the distance data within the group, X-coordinates at the left and right ends of the group and the like and with respect to the group classified "side wall", those parameters include an arrangement direction of the data (gradient with respect to Z-axis), Z, X coordinates of the front and rear ends of the group and the like. In this embodiment, in order to raise the accuracy of classification, the group is reclassified according to the calculated gradient of the overall group, however this reclassification may be omitted.

IN THE CLAIMS

Simultaneously with the filing of this Continuation Application prior to examination please cancel claims 1-5 without prejudice or disclaimer, and substitute the following new claims therefor.

6.(new) A vehicle surroundings monitoring apparatus having a stereoscopic image detecting unit for detecting a stereoscopic image around a self vehicle, an image processor for processing said image into a distance image and a recognition computer for recognizing objects based on said distance image, comprising:

grouping means for grouping positional data representing a side wall of a particular object arranged

along a boundary of a road on which said self vehicle is running; and

wall surface detecting means for detecting an outline of said side wall by performing a pattern matching of a side wall surface pattern to said positional data of said side wall, said side wall surface pattern being suitable for said particular object.

7. (new) The apparatus according to claim 6, wherein said wall surface detecting means is adopted to perform the pattern matching successively along a wall surface model represented by the combination of a plurality of nodes arranged at a predetermined interval ahead of said self vehicle.

8. (new) The apparatus according to claim 7, wherein said wall surface detecting means is adopted to apply said side wall surface pattern to said positional data of said side wall within a searching area provided around each node of said wall surface model.

9. (new) The apparatus according to claim 8, wherein said side wall surface pattern is represented by a weight coefficient being variable depending on a distance from a central point of said pattern.

10.(new) The apparatus according to claim 9, wherein said wall surface detecting means is adopted to recognize a position of the central point of said side wall surface pattern as a node of said wall surface model when the degree of coincidence of the pattern matching becomes maximum while said side wall surface pattern is shifted towards a lateral direction.

11.(new) The apparatus according to claim 10, further comprising correcting means for correcting coordinates of each node of said wall surface model set by said wall surface detecting means in the direction of bringing said each node close to a straight line connecting two adjacent nodes.

R E M A R K S

The specification has been amended as in the parent application 09/238,228 for purposes of clarity. These amendments are formal in nature. The term "solid object" was used in the specification in different contexts. The term "solid object" has been amended in the appropriate places to "faced wall". The term "faced wall" represents a front wall of an object faced with the vehicle. Other instances of the term "solid object" remain unamended.

The present invention as claimed in new claims 6-11 is not anticipated by nor obvious from the reference Sogawa (US Patent 6,169,572 cited in the parent application, not specifically against claims 6-11 which were not considered as raising new issues. Please consider these claims in the present application.

The present invention as claimed in independent claim 3 (allowed in the parent application which is issuing into a patent) and claim 6 includes the following features:

1) A wall surface positional data group classified in a wall surface forming a boundary of a road is extracted from positional data objects;

2) A plurality of nodes (Nj) are obtained from the wall surface positional data group, so that a wall surface model for expressing an outline of the wall surface can be formed; and

3) Means for the improving precision of the wall surface model through pattern matching is provided.

Hereby, even if the road is curved or has no clear white line, the vehicle surrounding monitoring apparatus of the present claimed invention is able to easily recognize the shape of the road. On the other hand, the cited reference, Sogawa discloses that the side wall of the road is recognized as an approximate straight line through conducting the "Hough" transformation to data of the side wall within a searching area thereof. Sogawa neither discloses nor suggests improving the precision of the wall surface model through pattern matching as in the present claimed invention.

Furthermore, Sogawa neither discloses nor suggests a vehicle surroundings monitoring apparatus including the above disclosed elements as in the present claimed invention. Therefore, it is respectfully submitted that the present claimed invention is extremely different and neither taught nor obvious from the cited references and therefore all claims (claims 6-11) in the present application are believed to be allowable over the prior art of record.

Attached hereto is a marked-up version of the changes made to the specification ~~and claims~~ by the current amendment. The attached pages are captioned "Version with markings to show changes made"

In the event there are further issues remaining the Examiner is respectfully requested to telephone attorney to reach agreement to expedite issuance of this application.

Since the present claims set forth the present invention patentably and distinctly, and are not taught by the cited art either taken alone or in combination, this amendment is believed to place this case in condition for allowance and the Examiner is respectfully requested to reconsider the matter, enter this amendment, and to allow all of the claims in this case.

Respectfully submitted,
Keiji Hanawa

by:_______________________
Martin A. Farber
Attorney for Applicant
Registered Representative
Registration No. 22,345

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Further, based on the arrangement direction of the distance data of the overall groups, i.e., the gradient with respect to the Z-axis, the groups are classified into [solid object] faced wall groups or side wall groups. For the [solid object] faced wall groups, parameters such as a mean distance, X coordinates of the left and right ends and the like are calculated from the distance data of the group. Further, for the side wall groups, parameters such as the arrangement direction (gradient with respect to the Z-axis), the positions of the forward and backward ends in terms of Z-X coordinates and the like are calculated. Thus, [the front end,] the side surface [and the rear end] of a solid object and the structure such as a guardrail are detected as the side wall arranged along the road.

Please replace the paragraph beginning at page 11, line 8, with the following rewritten paragraph:

The programs shown in Figs 3 through 5 are ones for classifying the [solid object] faced wall group and the side wall group by processing the distance data obtained from the distance image. First, at a step S101, the distance image is divided into lattice-like strips having a given interval (for example 8 to 20 picture elements) and at S102 data of a solid object are extracted for every strip and the data of the first strip are read to calculate the distance to the object.

Please replace the paragraph beginning at page 15, line 11, with the following rewritten paragraph:

That is, at S121 the data of the first group are read and at S122 the arrangement direction of the data of the respective strips is calculated. Further, at S123 these strips are labeled as ["object"] faced wall or "side wall", respectively. Specifically, first two points on the X-Z plane are picked up from the data of the first group. One point (X1, Z1) is a middle point of a strip K1 at the left end of the first group and the other point (Xp, Zp) is a middle point of a strip far away from the left end strip K1 by an interval of N strips in the right hand direction. Then, a line connecting these two points is drawn on the X-Z plane and a gradient A1 of the line is calculated. When the gradient A1 is compared with a prescribed value, for example 45 degrees, if the gradient A1 is larger than the value, the strip K1 is labeled as "side wall" and if the gradient A1 is smaller than the value, the strip K1 is labeled as ["object"] faced wall.

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The interval N between strips is preferably N = 2 to 4. The reason is that N = 1, namely, an adjacent strip may produce fluctuations in the arrangement direction of the data due to the dispersion of detected distance and as a result it becomes difficult to make discrimination between "side wall" and ["object"] faced wall. Therefore, it is suitable to use not an adjacent strip, but a strip a little distant. Hereinafter, the labeling of "side wall" or ["object"] faced wall is performed successively from the left end strip up to the strip apart by N strips on the left side of the right end strip.

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The following steps S132 to S137 are of processes in which further classifications of "side wall" or ["object"] faced wall are carried out to raise the accuracy of the classification performed at S127. After the data of the first group are read at S132, at S133 approximate straight lines are obtained from the positions (Xi, Zi) within the group according to the Hough transformation or the linear square method to calculate a gradient overall the group.

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reclassified according to the calculated gradient of the overall group, however this reclassification may be omitted.